

## Recent Advances in Science in Western Australia

### Earth Sciences

This study by J Clarke, of Western Mining Corporation, confirms the great age of the landscape of the Yilgarn Craton. The relict saprolite dates back to the Late Permian-Middle Jurassic. Stripping of this regolith occurred in the Middle Jurassic-Early Eocene during the formation of the palaeodrainage system. About 400 m of material was denuded from the craton to infill adjoining sedimentary basins, and further deep weathering occurred concurrently with erosion. Increasing aridity led to disorganization of the drainage to form a chain of lakes. Aridity increased in the Kambalda area in the Pliocene, leading to the establishment of the present-day semi-arid geomorphic regime. However, aridity has persisted for only 2% of the history of the Kambalda landscape, and arid geomorphic models are only appropriate for understanding the most recent evolution of the regolith.

Clarke J D A 1994 Geomorphology of the Kambalda region, Western Australia. *Australian Journal of Earth Sciences* 41:229-239.

This thematic issue, edited by N Exon (AGSO, Canberra) documents various studies of the Mesozoic rocks of the North West Shelf, based on samples and seismic profiles acquired on two cruises of the AGSO research vessel *Rig Seismic*. Six papers examine palaeontology, one examines sedimentary petrology, one examines igneous petrology, three examine seismic profiling, and one examines the Wallaby profile. There is also an overview of the shelf and a synthesis of the results of the various papers. This volume provides an important contribution to our understanding of a major petroleum province.

Exon N F (Editor) 1994 Thematic issue: Geology of the outer North West Shelf, Australia. *AGSO Journal of Australian Geology & Geophysics* 15:1-190.

D Lowe, of Stanford University (USA), considers that three well-documented occurrences of stromatolites older than 3.2 Ga are abiotic. Small conical structures in the Strelley Pool chert (Warrawoona Group, WA, 3.5 - 3.2 Ga) probably formed through evaporitic precipitation. A domal structure from the North Pole chert (also Warrawoona Group) formed by soft-sediment deformation. Domal and pseudocolumnar structures in laminated chert (Onverwacht Group, South Africa, 3.5 - 3.3 Ga) probably formed through inorganic precipitation.

Lowe D R 1994 Abiological origin of described stromatolites older than 3.2 Ga. *Geology* 22:387-390.

Most Neoproterozoic and Phanerozoic basins in Western Australia can be classified as Neoproterozoic, Palaeozoic or Mesozoic-Cainozoic based on their age of dominant fill and tectonic activity. This paper by R Hocking (GSWA, Perth) rationalizes the basin subdivisions using a common set of descriptive terms. The Savory, Amadeus, Officer and possibly the Yeneena and Karara Basins are Neoproterozoic. The Gunbarrel, Southern Bonaparte, Ord, Canning and Southern Carnarvon Basins are Palaeozoic. The Northern Bonaparte, Browse, Roebuck and Northern Carnarvon

Basins (together comprising the Westralian Superbasin) are Mesozoic-Cainozoic. The Perth Basin (with its outlier, the Collie Basin) contains both Palaeozoic and Mesozoic elements, while the Eucla and Bremer Basins are primarily Cainozoic depocentres.

Hocking R M 1994 Subdivisions of Western Australian Neoproterozoic and Phanerozoic sedimentary basins. *Geological Survey of Western Australia Record* 1994/4.

G Le Blanc Smith (GSWA, Perth) describes the coal resources of the Collie Basin, a fault-bounded, post-depositional pull-apart basin preserved as a consequence of right-lateral shear in a transitional setting. The 226 km<sup>2</sup> basin contains about 1200 m of Permian siliciclastics overlain by a veneer of Cretaceous rocks. The oldest Permian rocks were laid down in a glaciofluvial and glaciolacustrine setting, with fluvial to upper delta-plain alluvial coal deposition constituting the balance of the succession. The coal resources total 2400 Mt and are currently mined in four opencut and three underground mines; almost 80% is used for power generation. Over the past 100 years, about 100 Mt of coal has been produced.

Le Blanc Smith G 1993 Geology and Permian coal resources of the Collie Basin, Western Australia. *Geological Survey of Western Australia. Report* 38.

A remarkably well-preserved Frasnian radiolarian fauna is described by J C Aitchison (University of Sydney), from carbonate concretions in the Gogo Formation. It is the best preserved and most diverse Frasnian assemblage yet documented, with 57 species (41 new) assigned to 14 genera. All elements of the fauna are common, but it is dominated by ceratohiscids of which 11 are new species.

Aitchison J C 1993 Devonian (Frasnian) radiolarians from the Gogo Formation, Canning Basin, Western Australia. *Palaeontographica Abt. A* 228:105-128.

The incisoscutid arthrodire *Gogosteus sarahae* gen. et sp. nov. is described and illustrated by J Long (Western Australian Museum). This taxon, like many of the superbly preserved arthrodires from the Gogo Formation, is known from only a single specimen. It is represented by most of the headshield, trunkshield and dentition; the bones are uncrushed and preserved in three dimensions. As a result of the new material, the family Incisoscutidae Denison 1984 is redefined and the new superfamily Incisoscutioidea is defined to include Incisoscutidae and Camuropiscidae.

Long J A 1994 A second incisoscutid arthrodire (Pisces, Placodermi) from the Late Devonian Gogo Formation, Western Australia. *Alcheringa* 18:59-69.

Deep seismic reflection and magnetic data were collected along a 75 km traverse across the Darling Fault Zone by researchers from Curtin University and the University of Western Australia; 50 km of the traverse was over the Archaean Yilgarn Craton and 25 km was over the Perth Basin. The seismic data suggest that the crust beneath the western Yilgarn Craton is divided vertically into three structural zones. From 0 to 7-9 km, there is a zone of thin-skinned compressional tectonism expressed

as a series of thrusts, which links to a detachment surface at about 7-9 km depth. At 7-9 to 25 km, there is a zone with several minor detachments and a large intrusive igneous body. From 25 to 40 km, there is a zone of continuous seismic events that dip east at about 25°. The seismic data provide a good fault plane image of the Phanerozoic Darling Fault, which is distinct from the Precambrian proto-Darling Fault that is interpreted to coincide with a wide, non-reflecting zone extending west beneath the Perth Basin.

Middleton M F, Wilde S A, Evans B J, Long A, Dentith M & Morawa M 1995 Implications of a geoscientific traverse over the Darling Fault Zone, Western Australia. *Australian Journal of Earth Sciences* 42:83-93.

Correlation of rocks in the Savory Basin with those of adjacent basins is impeded by poor outcrop and lack of subsurface information, but two new correlations by collaborators from Macquarie University and GSWA (Perth) clarify the age and relationships of the Savory basin. First, the Skates Hill Formation contains distinctive stromatolites (*Acaciella australica*) previously recorded from the Bitter Springs Formation of the Amadeus basin. Second, the intergrading sandstone-diamictite of the Boondawari Formation is very similar to the intergrading Pioneer Sandstone-Olympic Formation of the Amadeus Basin; this correlation is also supported by carbon isotope chemostratigraphy.

Walter M R, Grey K, Williams I R & Calver C R 1994 Stratigraphy of the Neoproterozoic to Early Palaeozoic Savory Basin, Western Australia, and correlation with the Amadeus and Officer Basins. *Australian Journal of Earth Sciences* 41:533-546.

The Archaean supracrustal sequence at Forrestania contains at least five komatiitic belts, which can be traced along strike for over 30 km. Lithologies range from olivine cumulates, which crystallized at the interface between substrate and flowing lava, to spinifex-textured rocks which underwent rapid crystallization within ponded lobes. Characteristic associations of different rock types are interpreted in terms of variations in eruption rate, which presumably reflect proximity to the vent or major lava river. The channel-facies rocks (olivine cumulates) are flanked by sequences of spinifex-textured flow-units that formed from the episodic overflow of lava from the distributary channels.

Perring C S, Barnes S J & Hill R T 1995 The physical volcanology of Archaean komatiite sequences from Forrestania, Southern Cross Province, Western Australia. *Lithos* 34:189-207.

The geochemistry of the Perseverance and neighbouring Rocky's Reward nickel deposits, which are associated with metamorphosed komatiite flows erupted onto a substrate of felsic crystal tufts, is described by an international collaboration of researchers from CSIRO (Perth), the University of Alabama, and the University of Melbourne. The deposits are overlain by the Perseverance Ultramafic Complex, which consists of a central dunite lens flanked by olivine orthocumulates and spinifex-textured komatiites. Samples from the A-zones of komatiite flows fall into two distinct geochemical groups. Samples from flows flanking the central dunite show well-constrained linear trends of major and trace elements typical of komatiite suites related by simple olivine fractionation. Samples from the Perseverance

mine, Rocky's Reward and from unmineralized flows at the base of the Perseverance Ultramafic Complex all show evidence for light REE enrichment relative to the other group. Geochemical computer modelling suggests that the mineralization is due to wholesale assimilation of floor rocks close to the site of sulphide accumulation.

Barnes S J, Leshner C M & Keays R R 1995 Geochemistry of mineralised and barren komatiites from the Perseverance nickel deposit, Western Australia. *Lithos* 34:209-234.

Rock magentic properties and palaeomagnetism of weakly metamorphosed banded iron-formation (BIF) from the Palaeoproterozoic Hamersley Group and Proterozoic BIF-derived iron ores were investigated by P Schmidt and D Clark (CSIRO, North Ryde). Palaeomagnetic pole positions were calculated for BIFs at Paraburdoo (40.9°S, 218.9°E) and Wittenoom (36.4°S, 218.9°E) and for Mt Tom Price iron ore (37.4°S, 220.3°E) and Paraburdoo iron ore (36.4°S, 209.9°E). These poles are indistinguishable from each other, and from the Mt Jope Volcanics overprint pole. The magnetization of the BIFs was probably acquired during burial metamorphism of the Hamersley Group.

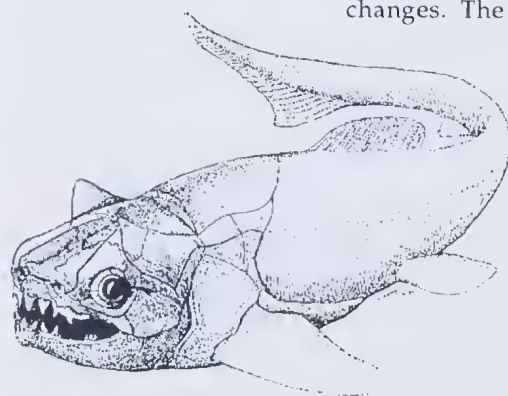
Schmidt P W & Clark D A 1994 Palaeomagnetism and magnetic anisotropy of Proterozoic banded-iron formations and iron ores of the hamersley basin, Western Australia. *Precambrian Research* 69:133-135.

Solid bitumen envelopes in Permian sandstones from the Kennedy Group are shown by B Rasmussen and J Glover (University of Western Australia) to be useful in subdividing the diagenetic sequence into three intervals, thus establishing the order of appearance of diagenetic minerals with greater precision than was previously possible. The envelopes develop from the polymerization of hydrocarbons around the radioactive detritals monazite, xenotime and zircon. Their paper reports the presence of authigenic florencite (Ce, La, Al phosphate) and xenotime (YPO<sub>4</sub>), and bitumen-filled fission tracks in monazite for the first time in Australian sedimentary rocks.

Rasmussen B & Glover J E 1994 Diagenesis of low-mobility elements (Ti, REEs, Th) and solid bitumen envelopes in Permian Kennedy Group sandstone, Western Australia. *Journal of Sedimentary Research* A64:572-583.

## Life Sciences

This most recent book published by John Long, of the Western Australian Museum, entitled 'The Rise of Fishes', provides a superbly illustrated history of the evolution of the fishes. It integrates aspects of geology, evolution, anatomy, and global environmental changes. The book is the first





complete account of the spectacular fossil history of the fishes over their 500 million year record, and provides a thorough discussion of the latest evidence for the evolution of the first fishes from invertebrates. Included in the book are hundreds of colour photographs and dramatic full-colour reconstructions of extinct fishes.

Long J A 1995 *The Rise of Fishes. 500 Million Years of Evolution*. Johns Hopkins University Press, Baltimore/University of New South Wales Press, Sydney.

This monograph by D Bickel examines all 253 species (with 208 newly described) of dipteran flies of the subfamily Sciapodinae. It describes aspects of morphology, fossil history, systematics, natural history, biogeography and accidental introductions, and systematics. It reviews all zoogeographic regions although it emphasises Australia and the Orient. Nine new genera are erected, and there are nomenclatural changes for taxa from all biogeographic regions.

Bickel D J 1995 *The Australian Sciapodinae (Diptera: Dolichopodidae)*, with a review of the Oriental and Australasian faunas, and a world conspectus of the subfamily. Records of the Australian Museum. Supplement 21.

Patterns of morphological diversity are examined by J Clements (University of Western Australia) and W Cowling (Department of Agriculture, WA) for 157 accessions of wild lupins *Lupinus angustifolius* from the Aegean region. Two groups with desirable agronomic characteristics originated in the Dodekanisos Islands; these had rapid and tall growth, prolific podding on the main stem, pods high off the ground, many upper lateral branches, large leaves, pods and seeds, and high seed yield.

Clements J C & Cowling W A 1994 Patterns of morphological diversity in relation to geographical origins of wild *Lupinus angustifolius* from the Aegean region. Genetic Resources and Crop Education 41:109-122.

Researchers from Murdoch University and the Department of Lands, Parks and Wildlife (Hobart) demonstrate a substantial correlation between the breeding ages of short-tailed shearwaters in pair bonds. This is largely explained by the prolonged pair-bond between mates and the predominant availability of unpaired, inexperienced birds. The probability of breeding success depends on the breeding ages of the partners and especially the length of their pair bond.

Bradley J S, Wooller R D & Skira I J 1995 The relationship of pair-bond formation and duration to reproductive success in short-tailed shearwaters *Puffinus tenuirostris*. Journal of Animal Ecology 64:31-38.

A survey of the Cenozoic fossil fauna of Barrow Island in northwestern Australia, by K McNamara and G Kendrick (Western Australian Museum), has yielded a rich fauna of Middle Miocene and Late Pleistocene molluscs, and Middle Miocene echinoid echinoderms. These faunas have little in common with the contemporaneous faunas from the Nullarbor Limestone in the Eucla Basin; the echinoid fauna has more in common with Miocene faunas of Java and India. The mollusc and echinoid faunas show strong affinities with modern communities.

McNamara K J & Kendrick G W 1994 Cenozoic molluscs and echinoids of Barrow Island, Western Australia. Records of the Western Australian Museum. Supplement 51.

The traditional and current uses of the genus *Eremophila*, Australian desert shrubs, have been reviewed by G Richmond (Curtin University) and E Ghisalberti (University of Western Australia). This ecologically-important genus is represented by over 200 species, of which 75% occur in Western Australia. Species of *Eremophila* have long been of cultural importance to the Aboriginal people. They are useful in revegetation programmes and have potential in horticulture and as sources of phytochemicals.

Richmond G S & Ghisalberti E L 1994 The Australian desert shrub *Eremophila* (Myoporaceae): medicinal, cultural, horticultural and phytochemical uses. Economic Botany 48:35-59.

Exposure of dormant seed to cold smoke, derived from burnt native vegetation, has a positive influence on germination in 45 of 94 species of native vegetation examined by researchers from Kings Park and Botanic Garden, and the University of Western Australia. Some species showed earlier germination if smoke-treated, whereas other species continued to germinate for a longer period of time if smoke-treated.

Dixon K W, Roche S & Pate J S 1995 The promotive effect of smoke derived from burnt native vegetation on seed germination of Western Australian plants. Oecologia 101:185-192

Researchers from the University of Western Australia have shown that the lesser long-eared bat *Nyctophilus geoffroyi* was attracted to both calling tettigoniid bushcrickets and synthesised tettigoniid calls broadcast through loud-speakers. More bats were attracted to long-duration than short-duration calls, whereas high calling rate or high calling intensity had no special attraction. Two-speaker choruses appeared to be more attractive than single-speaker choruses. These results are interpreted in the context of predation being a selective force on calling strategies of tettigoniid bushcrickets.

Hosken D J, Bailey W J, O'Shea J E & Roberts J R 1994 Localisation of insect calls by the bat *Nyctophilus geoffroyi* (Chiroptera: Vespertilionidae): a laboratory study. Australian Journal of Zoology 42:177-184.

B Lamont and E Witkowski provide a stage-by-stage protocol for identifying simple or biased lottery, or non-lottery, patterns of seedling recruitment. For four co-occurring species of Banksias after two experimental fires, seedlings still alive after 3 years of two (*Banksia speciosa* and *B. Baxteri*) conformed to a biased lottery whereas two (*B. coccinea* and *B. pulchella*) has no mathematical structure.

Lamont B B & Witkowski E T F 1995 A test for lottery recruitment among four *Banksia* species based on their demography and biological attributes. Oecologia 101:299-308.

## Physical Sciences

A group of researchers from the Chemistry Department at the University of WA and the Research School of Chemistry at the ANU in Canberra have made a detailed study of the synthesis and structure of bicyclic hexamine ligands, which can act as cages for metal ions. These ligands are very strong bases, accepting up to five protons with  $pK_a$ 's ranging from 0 to 12.

Bottomley G A, Clark I J, Creaser I I, Engelhardt L M, Geve R J, Hagen Ks, Harrowfield J M, Lawrance G A, Lay P A, Sargeson A M, See A J, Skelton B W, White A H & Wilner F R 1994 The synthesis and structure of encapsulating ligands:

properties of bicyclic hexamines. *Australian Journal of Chemistry* 47:143-179.

Electrical conductivities of simple electrolytes dissolved in 2-cyanopyridine have been measured by GT Hefter (Murdoch University) and M Salomon (US Army Power Sources Laboratory). Only weak association occurs in dilute solution because of the very high dielectric constant. A conductivity maximum is observed in the very concentrated solutions typical of nonaqueous batteries.

Hefter GT & Salomon M 1994 Conductivities of 1:1 salts in 2-cyanopyridine. *Journal of Solution Chemistry* 23:579-593.

Researchers at Murdoch University have made a quantum mechanical study of the effect of excess charge on bond strengths in silane molecules. The calculations show that both positive and negative charges reduce the bond strengths so that they can be broken even by infrared light. This effect may explain the well-known photo-degradation of amorphous silicon solar cells.

Clare BW, Talukder G, Jennings PJ, Cornish JCL & Hefter GT 1994 Effect of charge on bond strength in hydrogenated amorphous silicon. *Journal of Computational Chemistry* 15:644-652.

Chemists at Murdoch University have been able to synthesize asymmetric di-acetate derivatives of benzo [c] pyrans using titanium tetraisopropoxide. These compounds are related to aphid pigments.

Giles RGF & Joll CA 1995 An asymmetric synthesis of benzo [c] pyrans related to the aphid pigments. *Tetrahedron Letters* 36:1125-1126.

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*Note from the Hon Editor:* This column helps to link the various disciplines and inform others of the broad spectrum of achievements of WA scientists (or others writing about WA). Contributions to "Recent Advances in Science in Western Australia" are welcome, and may include papers that have caught your attention or that you believe may interest other scientists in Western Australia and abroad. They are usually papers in refereed journals, or books, chapters and reviews. Abstracts from conference proceedings will not be accepted. Please submit either a reprint of the paper, or a short (2-3 sentences) summary of a recent paper together with a copy of the authors' names and addresses, to the Hon Editor or a member of the Publications Committee: Dr S D Hopper (Life Sciences), Dr A E Cockbain (Earth Sciences), and Assoc Prof G Hefter (Physical Sciences). Final choice of articles is at the discretion of the Hon Editor.

"Letters to the Editor" concerning scientific issues of relevance to this journal are also published, at the discretion of the Hon Editor. Please submit a word processing disk with letters, and suggest potential reviewers or respondents to your letter. P C Withers, *Hon Editor, Journal of the Royal Society of Western Australia*.